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(54) **HEAT EXCHANGER.**

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Description

The present invention r lates to a heat exchanger with a double helical passage formed by two helical surfaces which are connected with their inner edges to a core and with their outer edges to a cylindrical wall of a casing so as to create the flows of a first heat exchange medium and a second heat exchange medium, both helical surfaces having the same angle of pitch, and with an inlet and an outlet for each of the flows, which inlet and outlet connects the double helical passage with supply and discharge pipes of the heat exchanger.

The heat exchanger is especially intended for use in the exchange of heat, preferably in counter flow, between flowable media, particularly between media that are employed as materials in a process for biogas production, and media that have been employed in such a process. However, the heat exchanger according to the invention is not limited to the above mentioned use, but can be used in other fields.

A heat exchanger of the above mentioned type is principally known from DE-C-178 080. In this patent specification no directions are given, however, for the construction of the inlets and the outlets or the connection of the inlets and outlets to the helical passages of the heat exchanger. However, the inlet and outlet may connect the double helical passage with supply and discharge pipes on the heat exchanger.

In the case of media having a relatively high viscosity problems can arise from clogging in the areas of the inlet and the outlet, and it is therefore important to construct the inlets and outlets in such a manner as to ensure good flow conditions through the heat exchanger.

In the case of flowable media having an inhomogenous composition, such as is often the case with materials intended for biogas production, it is particularly important to ensure good flow conditions in order to avoid depositions that may result in clogging or reduced flow through the heat exchanger. In either case, the efficiency will be reduced and it will be necessary to stop the operation of the heat exchanger in order to clean this by flushing the helical passages.

It is the object of the present invention to provide a heat exchanger, in which good flow conditions are obtained at the connection of the inlets and outlets with the heat exchanger itself, thereby to avoid clogging or at least to obtain a substantial reduction of clogging and deposition.

With this object in view, the features characteristic of the invention are that the inlet and the outlet are constructed substantially without change of the cross-sectional area from the helical passage through the inlet/outlet to the supply and discharge pipes, that the inlet and the outl t consist of pipe stubs the front walls of which are directed tangentially t the cylindrical wall and disp sed in a plane which t g ther with a plane perpendi ular to the longitudinal axis of the helical passages forms an angle which substantially corresponds t the angle of pitch f the helical surfac s and that at th end of ach stub a guide plate is provided between two adjacent helical surfaces, said guide plate extending tangentially from the core towards the cylindrical wall of the casing.

Thereby it becomes possible to obtain very advantageous flow conditions, because the flowing media are not subjected to sudden changes of direction in connection with their passing into and out of the heat exchanger, and because certainty is obtained that no cavities will be formed upstream of the inlet pipe stub or downstream of the outlet pipe stub. Such cavities could give rise to a variation of the cross-section and should therefore be avoided.

It is noted that the inlet and the outlet according to the present invention may be connected to the cylindrical wall of the casing or the end of the casing.

According to a further feature of the present invention, the pipe stubs are connected directly with the mouth of a helical passage, which mouth is provided at the end of the casing and is defined by the end of the cylindrical wall, the core and the ends of the two helical surfaces so that it becomes unnecessary to provide guide plates or the like means. Though the pipe stubs are connected directly with the mouth, care should be taken that the inlet and the outlet are so directed as above mentioned in order to ensure the optimum flow conditions.

In order to be able to connect the heat exchanger with outer equipment, such as pumps, storage tanks or fermentation tanks, by means of conventionally produced cylindrical pipes, it will be advantageous to construct the pipe stubs in such a manner that they change gradually from an approximately polygonal cross section at the connection with the heat exchanger to a circular cross-section at their connection with supply and discharge tubes for the heat exchanger.

In cases where the need of heat exchange is such that a heat exchanger according to the invention would have an inconveniently great length, it is possible to connect a heat exchanger in series with one or more similar heat exchangers in side by side arrangement. In this manner it becomes possible, within a relatively small construction length, to obtain long lengths of flow without substantial losses as a consequence of changes of direction of the flow of material through the heat exchangers.

If advantageous from the point of view of construction, one may use an arbitrary combination of the described methods of connecting the pipe stubs with the heat exchanger. E.g. the supply to and discharge from a heat exchanger consisting of a plurality of units can be provided by means of pipe stubs connect d directly with the mouths of the helical passages, while the mutual c nnection of the units is pr vided by means of pipe stubs connected with the cylindrical walls of the

individual casings.

The invention will now be d scribed in further detail with refer nc t the drawing, in which:

Fig. 1 is a diagrammatic view of one end of an embodiment of the heat exchanger according to the invention, where an inlet and an outlet are passed through a cylindrical wall of a casing of the heat exchanger,

Fig. 2 an end view of the heat exchanger of Fig. 1, and

Fig. 3 a diagrammatic part section through one end of the heat exchanger of Figs. 1 and 2 along the line III - III of Fig. 2.

Referring more particularly to Fig. 3 of the drawing, an embodiment of the heat exchanger according to the invention is illustrated, only one end being shown for the sake of clarity, the other end being constructed in the same manner. This heat exchanger 1 has two helical passages 2, 3 formed by two helical surfaces 4, 5, which are provided in the form of two plate strips, which are helically coiled and are welded along their inner edges to a core in the form of a tube 6, while their outer edges are welded to the cylindrical wall 10 of the casing 7. The two plate strips 4, 5 have the same angle of pitch θ and are arranged substantially midway between one another so that the helical passages have approximately equal cross-sectional areas. The cylindrical wall 10 may either consist of a cylindrical tube or may be provided in the form of coiled plate strips, which are welded to the outer edges of the plate strips 4, 5 so as to close the spaces between the plate strips 4, 5 and thereby to provide the helical passages 2, 3. The plate strips 4, 5 may alternatively be arranged at a displacement relative to one another so that the helical passages 2, 3 will have different cross-sectional areas.

In the embodiment illustrated, an inlet 8 and an outlet 9 are welded to the cylindrical wall 10 of the casing 7 in such a manner that there will be no sudden changes of direction, cavities or substantial changes of the cross-sectional area.

To get access to the helical passages 2, 3, a window is provided in the wall 10 for each of the pipe stubs 8, 9. These windows will now be described with reference to the inlet pipe stub 8 shown in the drawing. The window, which extends across an angle of approximately 90°, is delimited at a first side by a first generatrix 12 of the cylindrical wall 10. The first generatrix 12 is located at the line of intersection between a tangential plane to the cylindrical wall and the wall 10 itself. The window has a width corresponding to the distance between two adjacent plate strips 4, 5 and is thus delimited in the longitudinal direction of the heat exchanger by tw edg s 13, 14 l cat d at the welding line between th plate strips and the wall. The last side of the window is delimited by a second gen ratrix 15 f th ylindrical wall 10. The second gen ratrix 15 is located at the p int f intersection betwe n the wall 10 and a plane, which is parallel to the befor mentioned tangential plane, and which is a tangential plane t the tub 6.

The pipe stubs 8, 9 are arranged in such a manner that a front wall 16, as viewed from the end (see Fig. 2), is directed tangentially relatively to the wall 10 of the casing 7 and is welded to this wall along the first generatrix 12. A rear wall 17, which is parallel to the front wall 16, and which is located in a plane that is tangential relatively to the outer surface of the tube 6, is welded to the wall 10 along the second generatrix 15. The pipe stubs 8, 9 have two side walls 18, 19 which connect the front wall and the rear wall and are welded to the wall 10 along the edges 13 and 14. The pipe stubs 8, 9 are arranged in a plane, which together with a plane perpendicular to the longitudinal axis of the helical passages forms an angle θ (see Fig. 1), which is identical to the angle of pitch θ of the plate strips 4, 5 (see Fig. 3). The pipe stubs 8, 9 are gradually changed to a circular shape (not shown) from the approximately polygonal shape at the connection with the wall 10, whereby it becomes possible to connect the heat exchanger with other equipment by means of conventionally produced cylindrical pipes (not shown). For illustration, the pipe stubs 8, 9 are shown with an exaggerated length and can be shorter than shown.

In this embodiment, two guide plates 20, 21 are connected by welding between two adjacent plate strips 4, 5, and these guide plates are directed tangentially relatively to the tube 6. The guide plate 20 is moreover welded to a first generatrix 22 of the tube 6 and the above mentioned second generatrix 15 of the cylindrical wall 10.

The heat exchanger constructed as above described will have very advantageous flow conditions, and it is particularly suitable for use in the exchange of heat between materials employed in a process for biogas production, and materials that have been used in such a process. In such an inhomogenous mass there will be a minimum of precipitation and deposition owing to good flow conditions, and consequently it will rarely be necessary to clean the heat exchanger by flushing. Should it still become necessary to clean the heat exchanger, this can easily be done by flushing, because the cleaning medium can be passed in and out through the pipe stubs 8 and 9 and produce a sweeping of all interior surfaces. Thus, it is not necessary to provide special connecting stubs for flushing or to construct the heat exchanger with removable end covers in order to obtain flushing of all interior surfaces.

In the drawing, the flows of the media are indicated by arrows as being in counter flow, but the heat exchanger may just as well be used for heat exchange in concurrent flow.

Though only one specific embodiment has been d scrib d, the heat exchanger according to the invention can als be constructed in other ways. E.g. the pipe stubs can be welded directly

to the mouth of the helical passages as long as th orientation of the pipe stubs in space, as above described, is observed. Moreover, it is p ssible to produce the conn ctions betw en the individual parts of the heat exchanger otherwise than by welding, e.g. by means of an adhesive.

Claims

1. A heat exchanger (1) with a double helical passage (2, 3) formed by two helical surfaces (4, 5) which are connected with their inner edges to a core (6) and with their outer edges to a cylindrical wall (10) of a casing (7) so as to create the flows of a first heat exchange medium and a second heat exchange medium, both helical surfaces having the same angle of pitch, and with an inlet (8) and an outlet (9) for each of the flows, which inlet and outlet connects the double helical passage (2, 3) with supply and discharge pipes of the heat exchanger characterized in that the inlet (8) and the outlet (9) are constructed substantially without change of the croßsectional area from the helical passage (2, 3) through the inlet/outlet (8, 9) to the supply and discharge pipes, that the inlet (8) and the outlet (9) consist of pipe stubs the front walls (16) of which are directed tangentially to the cylindrical wall (10) and disposed in a plane which together with a plane perpendicular to the longitudinal axis of the helical passages (2, 3) forms an angle (θ) which substantially corresponds to the angle of pitch of the helical surfaces (4, 5) and that at the end of each stub a guide plate (20, 21) is provided between two adjacent helical surfaces, said guide plate extending tangentially from the core (6) towards the cylindrical wall (10) of the casing (7).

2. Heat exchanger according to claim 1, characterized in that the pipe stubs are directly connected with the mouth of a helical passage, which mouth is provided at the end of the casing and is defined by the end of the cylindrical wall (10), the core (6) and the ends of the two helical surfaces (4, 5).

3. A heat exchanger according to either of the beforegoing claims, characterized in that the cross-sectional areas of the two helical passages (2, 3) are substantially equal.

4. A heat exchanger according to any of the beforegoing claims, characterized in that the pipe stubs are gradually changed from a substantially polygonal cross-section at their connection with the heat exchanger to a substantially circular cross-section at their connection with supply and discharge pipes for the heat exchanger.

5. A heat exchanger according to any of the bef r g ing claims, characteriz d in that it is connect d in series with ne or more similar h at exchangers in side by side arrangement.

Pat ntansprüche

1. Wärmetauscher (1) mit zwei schraubenlinienförmig n Kanälen (2, 3), die von zwei Schraubenflächen (4, 5) gebildet sind, deren Innenränder mit einem Kern (6) und deren Außenränder mit einer zylindrischen Wand (10) eines Gehäuses (7) verbunden sind, um die Strömungen eines ersten und eines zweiten Wärmeaustauschmediums zu bilden, wobei die beiden Schraubenflächen den gleichen Steigungswinkel (θ) haben, und mit einem Einlaß (8) und einem Auslaß (9) für jede der Strömungen, wobei der Einlaß (8) und der Auslaß (9) die zwei schraubenlinienförmigen Kanäle (2, 3) mit Zuführ- und Abführrohren des Wärmetauschers verbindet, dadurch gekennzeichnet, daß der Einlaß (8) und der Auslaß (9) im wesentlichen ohne Veränderung der Querschnittsfläche von den schraubenlinienförmigen Kanälen (2, 3) über den Einlaß/Auslaß (8, 9) zu den Zuführ- und Abführrohren ausgebildet sind, daß der Einlaß (8) und der Auslaß (9) aus Rohrstutzen bestehen, deren Frontwände (16) tangential zu der zylindrischen Wand (10) gerichtet und in einer Ebene angeordnet sind, die zusammen mit einer zu der Längsachse der schraubenlinienförmigen Kanäle (2, 3) rechtwinkligen bene einen Winkel (θ) bildet, der im wesentlichen dem Steigungswinkel der Schraubenflächen (4, 5) entspricht, und daß am Ende eines jeden Rohrstutzens eine Führungsplatte (20, 21) zwischen zwei benachbarten Schraubenflächen angeordnet ist, wobei sich die Führungsplatte vom Kern (6) tangential zu der zylindrischen Wand (10) des Gehäuses (7) hin erstreckt.

2. Wärmetauscher nach Anspruch 1, dadurch gekennzeichnet, daß die Rohrstutzen mit der Mündung eines schraubenlinienförmigen Kanals unmittelbar verbunden sind, wobei die Mündung am Ende des Gehäuses angeordnet und durch das Ende der zylindrischen Wand (10), dem Kern (6) und die Enden der Schraubenflächen (4, 5) begrenzt ist.

3. Wärmetauscher nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Querschnittsflächen der beiden schraubenlinienförmigen Kanäle (2, 3) im wesentlichen gleich sind.

4. Wärmetauscher nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Rohrstutzen von einem im wesentlichen polygonalen Querschnitt an ihrer Verbindung mit dem Wärmetauscher stetig in einen im wesentlichen kreisförmigen Querschnitt an ihrer Verbindung mit der Zu- und Abführleitung es Wärmetauschers übergehen.

5. Wärmetauscher nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß er mit inem oder mehreren ähnlichen Wärmetauschern in nebeneinandeliegender Anordnung in Serie geschaltet ist.

Revendications

1. Echangeur de chaleur (1) avec un passage n double hélice (2, 3) formé par deux surfaces hélicoïdales (4, 5) qui sont relié s par leurs bords internes à un noyau (6) et par leurs bords externes à une paroi cylindrique (10) d'un logement (7) de façon à créer les écoulements d'un premier milieu d'échange de chaleur et d'un second milieu d'échange de chaleur, les deux surfaces hélicoïdales ayant le même angle de pas, et avec une entrée (8) et une sortie (9) pour chacun ces écoulements, lesdites entrée et sortie reliant le passage en double hélice (2, 3) à des tubes d'alimentation et d'évacuation de l'échangeur de chaleur, caractérisé en ce que l'entrée (8) et la sortie (9) sont construites sensiblement sans changement de l'aire en section transversale depuis le passage hélicoïdal (2, 3) à travers l'entrée/sortie (8, 9) vers les tubes d'alimentation et d'évacuation, en ce que l'entrée (8) et la sortie (9) consistent en tronçons de tube dont les parois frontales (16) sont dirigées tangentiellement par rapport à la paroi cylindrique (10) et sont disposées dans un plan qui forme avec un plan perpendiculaire à l'axe longitudinal des passages hélicoïdaux (2, 3) un angle θ qui correspond sensiblement à l'angle de pas des surfaces hélicoïdales (4, 5) et en ce qu'à l'extrémité de chaque tronçon est prévue une plaque de guidage (20, 21) entre deux surfaces hélicoïdales adjacentes, ladite plaque de guidage s'étendant tangentiellement à partir du noyau (6) vers la paroi cylindrique (10) du logement (7).

2. Echangeur de chaleur selon la revendication 1, caractérisé en ce que les tronçons de tube sont reliées directement à l'embouchure d'un passage hélicoïdal, ladite embouchure étant prévue à l'extrémité du logement et étant définie par l'extrémité de la paroi cylindrique (10), le noyau (6) et les extrémités des deux surfaces hélicoïdales (4, 5).

3. Echangeur de chaleur selon l'une des revendications précédentes, caractérisé en ce que les aires en section transversale des deux passages en hélice (2, 3) sont sensiblement égales.

4. Echangeur de chaleur selon l'une quelconque des revendications précédentes, caractérisé en ce que les tronçons de tube changent graduellement d'une section transversale sensiblement polygonale à leur connexion avec l'échangeur de chaleur à une section transversale sensiblement circulaire à leur connexion avec les tubes d'alimentation et d'évacuation de l'échangeur de chaleur.

5. Echangeur de chaleur selon l'une quelconque des revendications précédentes, caractérisé en ce qu'il est connecté en série à un ou plusieurs échangeurs de chaleur similaires en agencement côte à côte.

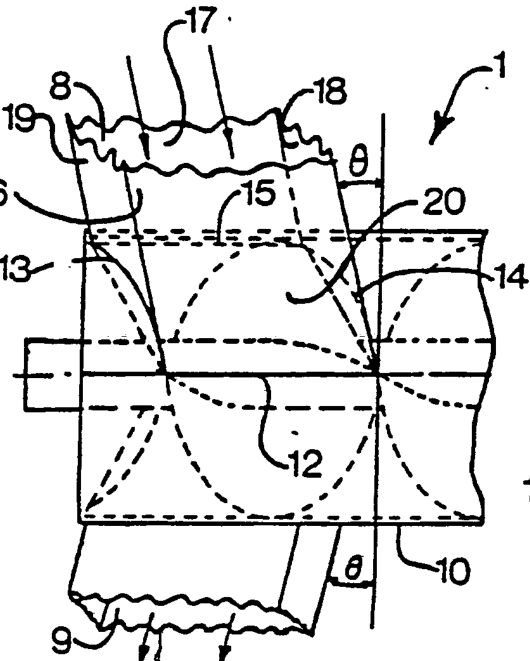

FIG.1

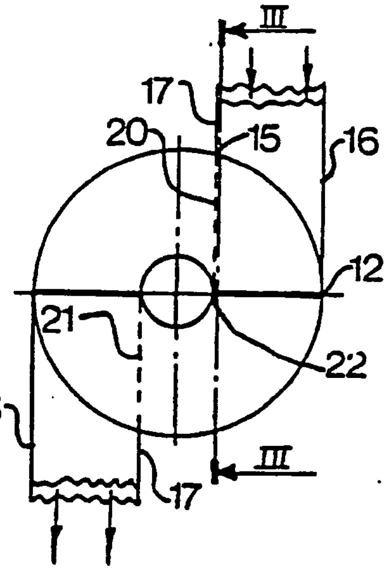

FIG. 2

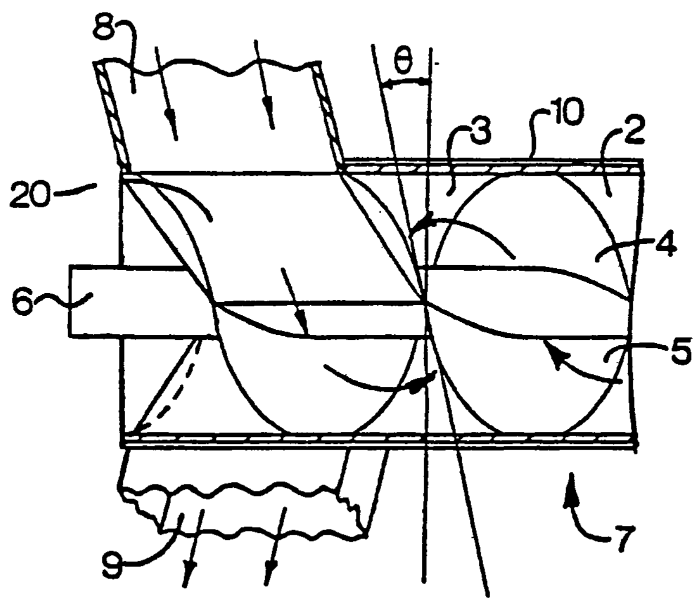

FIG.3